PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in and relating to Electric Circuit Breakers with Arc-extinguishing Arrangements.

I, WILLIAM WARREN TRIGGS, a member of the firm of Marks & Clerk, of 57 & 58, Lincoln's Inn Fields, London, W.C. 2, a British subject, do hereby declare the nature of this invention (a communication to me from abroad by Felten & Guilleaume Carlswerk Actien-Gesellschaft, of Köln-Mülheim, Germany, a German Company), and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Circuit breakers are known in which the electric arc produced when the circuit is broken is extinguished in a chamber by means of a gas under pressure, the arrangement being such that the gas is capable of quickly escaping, whereby the electric arc is cooled and in consequence thereof extinguished. The present invention relates to a circuit breaker of this character.

According to the invention, a space which is closed with respect to the chamber above referred to is evacuated or nearly evacuated when the circuit breaker is being opened and shortly before the termination of the opening movement of the circuit breaker, is quickly placed into communication with the arc chamber, so that the gas which is under pressure therein can escape into the evacuated space. In this way the electric arc is extinguished.

The extinguishing action can be further improved if the gas under pressure is throttled in front of the electric arc and is then caused to escape into the evacuated space.

The improved circuit breaker consists of an arc or circuit-breaker chamber and a cylinder connected therewith, in which a piston disc on the movable contact is so arranged as to be capable of being displaced. When the circuit breaker is being opened, a vacuum is produced in the cylinder, which can be quickly connected to the circuit-breaker chamber by means of a valve disc provided between the circuit-breaker chamber and the cylinder.

According to a further feature of the invention, the cylinder provided with the piston disc is constructed in such a manner as to be double-acting.

According to the invention, the gas in the cylinder is subjected to a high pressure and is conducted through a connecting conduit to the arc chamber, whence it escapes shortly before the termination of the opening of the circuit breaker to the other evacuated space of the cylinder. In order that the extinction should be as complete as possible, heat is extracted from the gas during the compression, so that the temperature of the gas shall not rise. The gas is thus isothermically compressed. The cooling of the gas during the compression may be effected in a simple manner by this that the connecting conduits leading to the arc chamber are provided in the wall of the circuit-breaker. Instead thereof use may be made of separate cooling devices. Valves are provided in the piston disc which open when the circuit-breaker is being closed, so that the gas which has escaped from the arc chamber can pass into the compression space of the cylinder. In order to replace any loss in gas which may have occurred in the circuit-breaker, the circuit-breaker chamber is preferably connected to a separate reservoir in which gas required for the circuit-breaker is stored under high pressure. If the pressure of the gas present in the circuit-breaker chamber and in the cylinder of the circuit-breaker drops under a predetermined value a definite amount of gas flows from the reservoir into the circuit-breaker chamber until the gas again attains the required pressure in the said circuit-breaker chamber and the cylinder. If the gas which has once been used during the opening of the circuit breaker is not removed from the latter but is further used for switching purposes, it is preferably purified before each switching operation by being blown through a filtering device provided between the cylinder and the circuit-breaker chamber and built in the wall of the circuit-breaker, being at the same time used as a cooling device; in this way the metal particles which have become detached from the contacts dur-

[*Price* 1/-]

ing the breaking of the circuit are removed from the gas employed in the circuit-breaker.

One mode of carrying the invention into effect is illustrated by way of example in the accompanying drawing; the circuit-breaker casing comprising the circuit-breaker chamber *b* and the cylinder *c* is mounted on the insulator *a*. *d* is the fixed and *e* the movable contact. Between the circuit-breaker chamber *b* and the cylinder *c* there is provided a valve disc *f* which makes a gas-tight joint with respect to the movable contact *e* and which is pressed by means of springs against the opening of the circuit-breaker chamber *b*. A piston disc *g*, which is made gas-tight with respect to the cylinder wall is mounted in such a manner on the movable contact *e* in the cylinder *c* that, when the circuit-breaker is closed, it lies on the side of the cylinder *c* facing the circuit-breaker chamber and when the circuit-breaker is in the opened position, it lies on the side of the cylinder *c* facing away from the circuit-breaker chamber *b*. The valve disc *f* is lifted off its seat by the movable contact *e* shortly before the termination of the opening movement of the circuit breaker. For this purpose the movable contact *e* is provided with a pin *h*. The circuit-breaker chamber *b* is connected with the cylinder *c* by means of connecting conduits *i* provided in the wall of the circuit-breaker. The cylinder *c* and the piston *g* are made double-acting so that the gas is compressed in the cylinder *c* when the circuit-breaker is being opened, whilst at the same time a vacuum is produced on the other side of the piston *g*. Preferably the volume of the cylinder *c* is substantially larger than the volume of the circuit-breaker chamber *b* so that the gas shall be strongly compressed when the circuit-breaker is being opened and at the same time a large vacuum space be formed.

Fig. 1 shows the improved circuit-breaker in the switched-on position. Gas is contained in the cylinder *c*, the circuit-breaker chamber *b* and in the intervening conduits *i*. The pressure of the gas is the same throughout. When the circuit-breaker is being opened, the piston *g* is moved upwards in the cylinder *c*, whereby as will be seen from Fig. 2, the gas which is present in the cylinder *c*, the circuit-breaker chamber *b* and the conduits *i* is strongly compressed. By arranging the conduits *i* in the wall of the circuit-breaker, heat is withdrawn from the gas during the compression so that the latter proceeds isothermically. Moreover, any impurities which may be contained in the gas are removed in the conduits *i*. When the circuit-breaker is almost fully open, a complete or partial vacuum is produced at the same time in the cylinder *c* on the side facing the circuit-breaker chamber *b*.

If the movable contact *e* is further moved upwards, the valve *f* provided between the circuit-breaker chamber *b* and the cylinder *c* is lifted off its seat by the pin *h* provided on the movable contact *e*, as will be seen from Fig. 3, so that the gas which is under high pressure in the circuit-breaker chamber *b* can suddenly enter into the evacuated space, whereby the arc is extinguished.

The circuit breaker may be constructed in such a manner that a small amount of gas can be held between the piston *g* and the cylinder cover *k*, whereby the opening movement of the circuit-breaker is attenuated at the last moment.

When the circuit-breaker is being closed, the valves *l* provided in the piston *g* are opened, so that the gas which has escaped from the circuit-breaker chamber *b* can again enter into the compression space of the cylinder *c*. A safety valve *m* may be provided in the cover *k* of the cylinder *c* so that the cylinder shall not be damaged by a very high pressure. The valve *f* provided between the circuit-breaker chamber *b* and the cylinder *c* acts as a safety valve for the circuit-breaker chamber. A flask *n* acting as a reservoir is provided on the circuit-breaker chamber *b* for the purpose of replenishing any loss in gas, the said flask being used to store the gas under high pressure.

A valve *p* is provided in the connections *o* between the circuit-breaker chamber *b* and the reservoir *n*. The said valve *p* is so adjusted that it opens when the pressure of the gas in the circuit-breaker *b* drops below a pre-determined admissible value, so that the required amount of gas can flow out of the reservoir *n*. The latter is preferably provided with a signalling device, which will indicate at the attendant's place when the reservoir is empty. For this purpose, a valve *q* is provided on the reservoir *n* which is so adjusted that it opens when the pressure therein and thus the amount of gas present therein drops below a predetermined value. In that case two auxiliary contacts *s* are bridged over by a contact spring *r* provided on the valve *q*, whereby a signalling device provided at the attendant's place is closed. The reservoir *n* may be provided, as will be seen from Fig. 1, in the insulator *a* of the circuit-breaker. The flask *n* does not occupy a separate space. The loss that

comes into question can naturally be made good from a gas reservoir far away from the circuit-breaker, the gas being led to the circuit-breaker chamber through a separate pipe.

The improved circuit-breaker may be constructed in such a manner that the gas which has been used once during the opening of the circuit-breaker is removed from the latter and a definite amount of fresh gas is allowed to flow thereto from the reservoir.

Use is preferably made of an electrically non-conducting and non-combustible gas, for instance carbon dioxide (CO_2). Use may be made instead; of chlorine (Cl_2), of ammonia (NH_3), or sulphur dioxide (SO_2). If necessary, precautions may be taken to prevent the gas from attacking the metal parts of the circuit-breaker. Instead of the gases above mentioned, use may also be made of vapours which are produced from a liquid by the arc formed at the opening of the circuit-breaker, since the said gases are nothing but highly superheated vapours.

For this purpose the circuit-breaker may be filled with a suitable liquid. When the circuit-breaker is being opened the arc causes part of the liquid to be vaporised and the vapour to attain a high pressure. At the same time the chamber which is in communication with the circuit-breaker chamber is evacuated or nearly evacuated, and shortly before the termination of the opening movement, it is quickly connected to the circuit-breaker chamber so that the high pressure vapour produced from the liquid by the arc can escape into the evacuated chamber. If use is made of a liquid in the circuit-breaker, difficulties may be encountered more particularly when the liquid is conductive. Moreover, a circuit-breaker provided with a liquid in the circuit-breaker chamber must have a heating device or means for preventing freezing have to be added to the liquid, otherwise the circuit-breaker cannot be mounted in open spaces. Moreover, in the case of a liquid circuit-breaker, special precautions have to be taken so that a sufficiently high vapour pressure is obtained when a circuit of small output is interrupted.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A method of breaking an electric circuit in which the arc is extinguished by means of a gas under pressure, characterised by the feature that when the circuit-breaker is being opened, the pressure of the gas in the circuit-breaker chamber is increased to a high value and that a chamber in communication with the circuit-breaker chamber is freed or nearly freed of gas and shortly before the termination of the opening movement of the circuit-breaker it is quickly connected to the circuit-breaker chamber so that gas under high pressure therein can escape into the evacuated chamber.

2. A method according to claim 1, characterised by the feature that the gas is isothermically compressed in a double-acting cylinder when the circuit-breaker is being opened and is led through conduits to a circuit-breaker chamber whence it escapes shortly before the termination of the opening movement of the circuit-breaker into an evacuated space of the double-acting cylinder.

3. A method according to claim 1 or 2, characterised by the feature that the compressed gas is throttled before it flows past the path of the electric arc.

4. A circuit-breaker according to the method claimed in claim 1 or 2, characterised by the feature that it consists of a circuit-breaker chamber *b* and a cylinder *c* connected therewith, a piston which is made gas-tight with respect to the cylinder wall being displaceably arranged therein.

5. A circuit-breaker according to claim 4, characterised by the feature that the cylinder is mounted above the circuit-breaker chamber.

6. A circuit-breaker as claimed in claims 4 and 5, characterised by the feature that the piston is provided in such a manner on the movable contact of the circuit-breaker that when the circuit-breaker is in the switched-on position, it lies on the side of the cylinder facing the circuit-breaker chamber and when the circuit-breaker is in the opened position, it lies on the side of the cylinder facing away from the circuit-breaker chamber.

7. A circuit-breaker according to claim 4, characterised by the feature that the volume of the cylinder is larger than that of the circuit-breaker chamber.

8. A circuit-breaker according to claim 4, characterised by the feature that a valve disc is provided between the circuit-breaker chamber and the cylinder, being made gas-tght with respect to a movable contact and actuated by the latter.

9. A circuit-breaker according to claim 4, characterised by the feature that the valve is lifted off the opening of the circuit-breaker chamber shortly before the termination of the opening movement of the circuit-breaker by a pin which is pro-

vided on the movable contact.

10. A circuit-breaker according to claim 4, characterised by the feature that the circuit-breaker chamber is connected with the cylinder by conduits.

11. A circuit-breaker according to claim 4, characterised by the feature that the connecting conduits are provided in the wall of the circuit-breaker.

12. A circuit-breaker according to claim 4, characterised by the feature that a filtering device is provided by means of which the gas is purified.

13. A circuit-breaker according to claim 4, characterised by the feature that the connecting conduits serve as a filtering device.

14. A circuit-breaker according to claim 4, characterised by the feature that the piston is provided with valves which are opened when the circuit breaker is being closed.

15. A circuit-breaker according to claim 4, characterised by the feature that gas for the circuit-breaker is stored in a flask or reservoir or a device which is connected by means of a feeding pipe to the circuit-breaker chamber, which gas serves to make good any possible loss in the gas used in the circuit-breaker.

16. A circuit-breaker according to claim 15, characterised by the feature that a valve is provided between the circuit-breaker chamber and the flask or reservoir, which valve opens when the pressure of the gas present in the circuit-breaker chamber and the cylinder drops below the pre-determined admissible value, so that the required amount of gas flows from the said flask or reservoir into the circuit-breaker chamber.

17. A circuit-breaker according to claim 15, characterised by the feature that a signalling device is provided which indicates when the store of gas in the flask or reservoir has been consumed.

18. A circuit-breaker according to claim 15, characterised by the feature that a valve is provided on the flask or reservoir which is so adjusted that it opens when the pressure in the flask or reservoir and the available amount of gas drop under a predetermined value, whereby the auxiliary contacts of the circuit of a signalling device are bridged over by a contact spring provided on the valve.

19. A circuit-breaker according to claim 15, characterised by the feature that the flask or reservoir is accommodated within the insulator of the circuit-breaker.

20. The improved circuit-breaker substantially as described and more particularly with reference to the accompanying drawings.

Dated this 23rd day of January, 1933.
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Fig. 1.

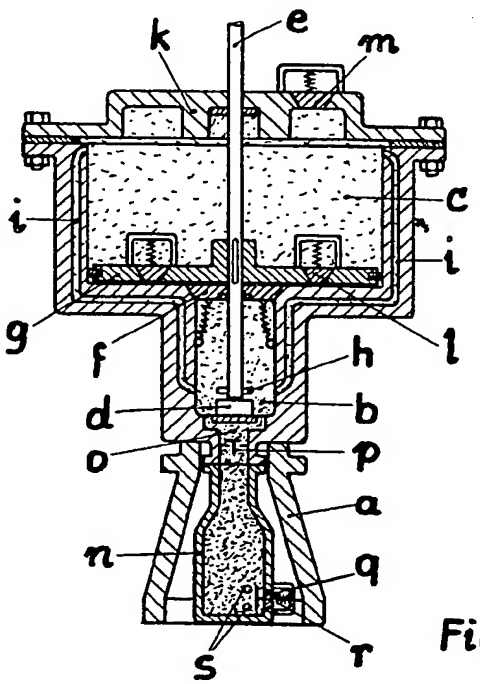


Fig. 2.

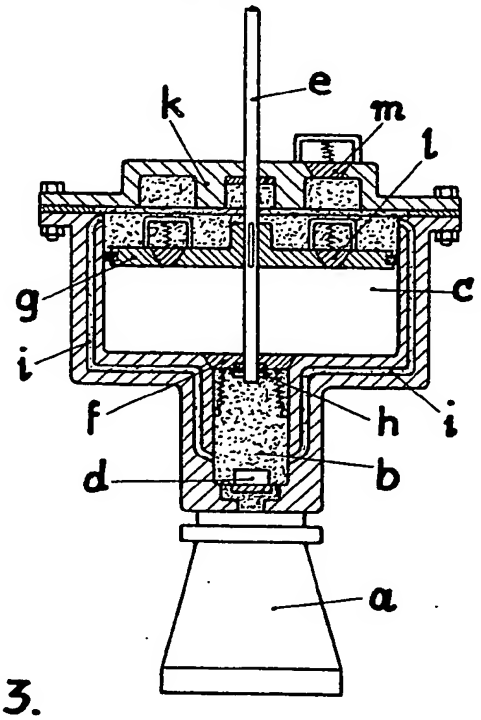
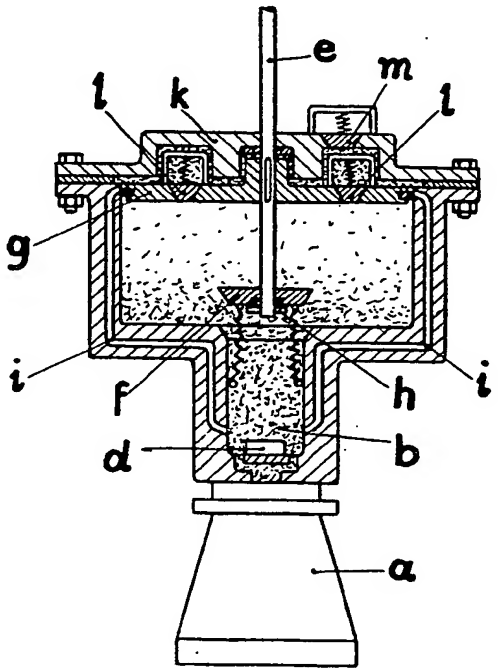


Fig. 3.



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